



POOL WATER TREATMENT
ADVISORY GROUP

PWTAG Annual Conference 2025
World Class Pool Water

CO₂-Based pH Neutralisation:

A Sustainable and Safe Approach for Swimming Pools

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6 November 2025

GENERATING A CLEANER FUTURE



Agenda

- Air Products at a glance
- General concepts
- Optimisation of CO₂ injection in swimming pools for pH neutralisation
- Additional resources

Air Products Today

 **12.1**
Billion dollars in sales

 **~23,000**
Employees worldwide

 **~50**
Countries where we operate

 **>60**
Billion dollars in market cap

 **>8**
Decades in business

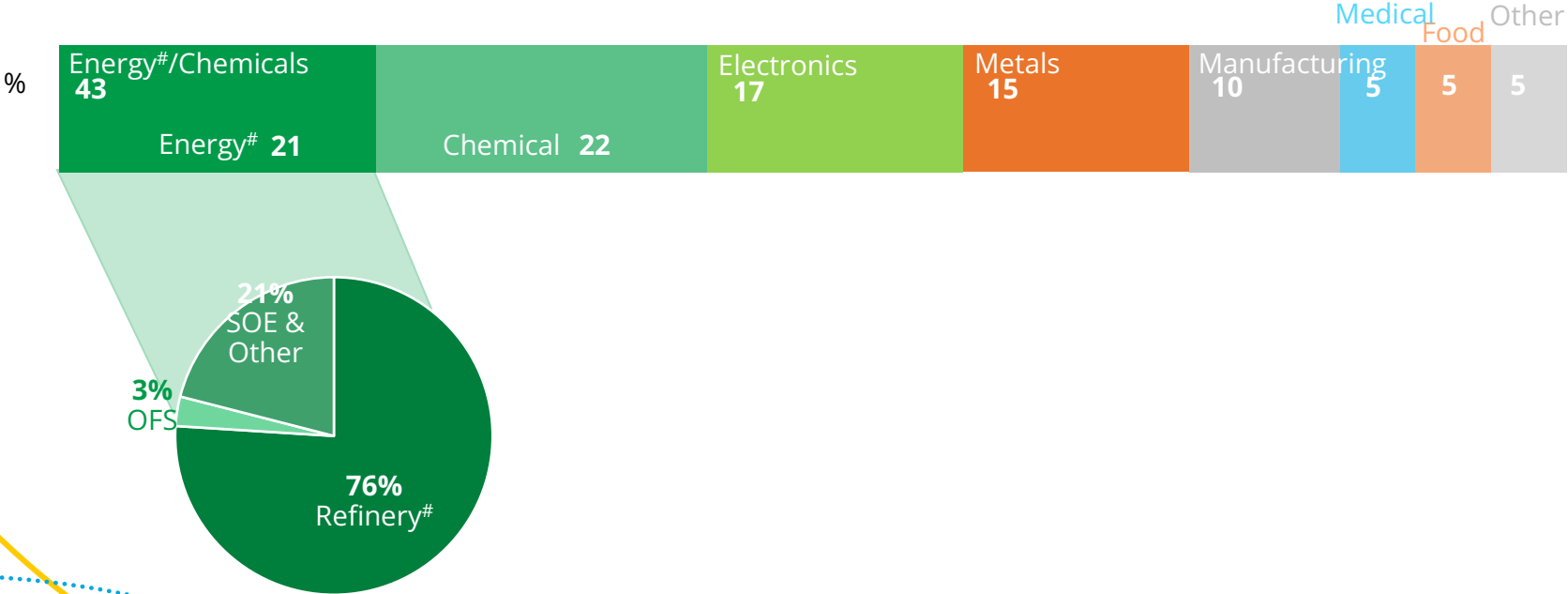
 **>250,000**
Customers

 **1,800**
Miles of industrial gas pipeline


 **750+**
Production facilities

 **30+**
Industries served

End Markets We Serve



APD Supply Modes




49%

HyCO# 22% ASU 27%

On-site/Pipeline

- 15-20+ year contracts
- Limited volume risk
- No energy/raw materials risks



34%

Liquid Bulk

- 3-5 year contracts
- Local supply chain



10%

Packaged Gas

- Short-term contracts
- Local supply chain



7%

Equipment & Services

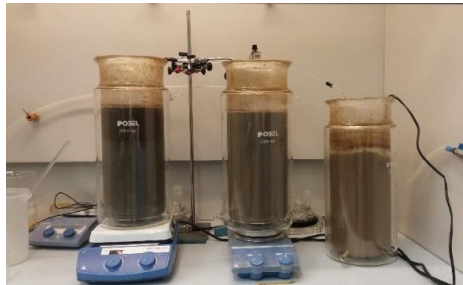
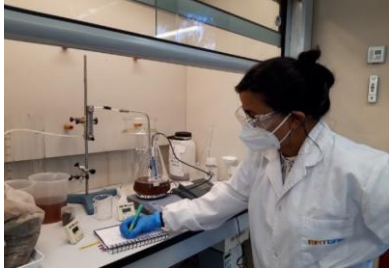
- Sale of equipment
- PO based

#The Jazan gasification and power joint venture is an equity affiliate. Its revenue is not included in reported sales.

Food and Water treatment Laboratories

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Water Treatment Lab



Food Preservation Lab



Water Treatment Lab: services and analytics

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- Specific studies, analysis and testing at lab scale
- Characterisation of water samples
- Customer process auditing: on-site investigations and assessments
- Simulation tools for aeration with O₂ and pH neutralisation with CO₂
- CO₂ dosage assessment for pH neutralisation
- O₃ dosage assessment for COD, colour removal, etc.
- Design and construction of pilot-scale demonstration plants
- Training, advice and technical assistance on water treatment technologies
- Connections with R&D Center and OEMs
- Development of research and innovation projects and technology transfer

- Lab scale prototypes
- UV-Vis spectrophotometer
- Turbidimeter
- Analytical equipment to determine pH, electrical conductivity, COD, dissolved O₂ and CO₂, water hardness and alkalinity, etc.
- Bench-scale test reactor for ozone dosage
- Testing Reports



Water Lab

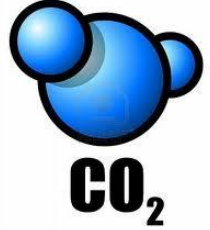
The most advanced technologies
for your water treatment needs

[Water Lab](#)

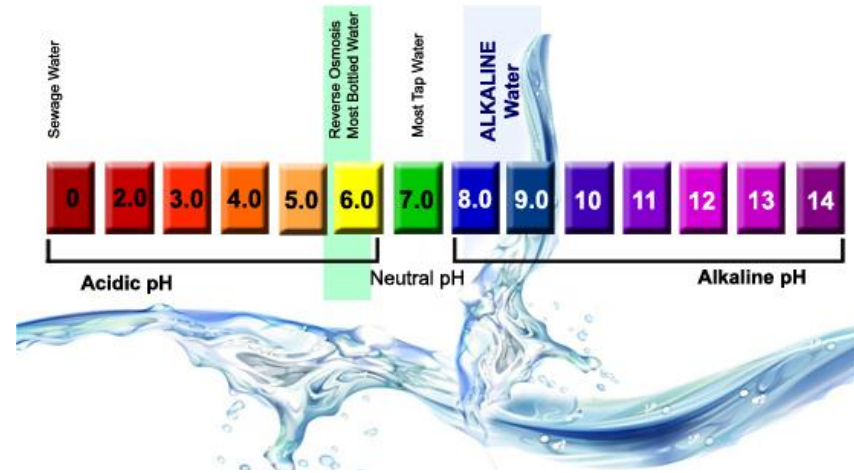
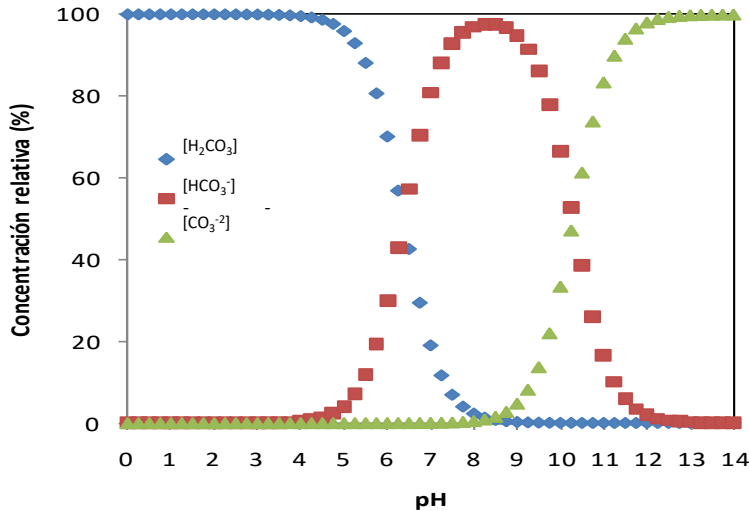
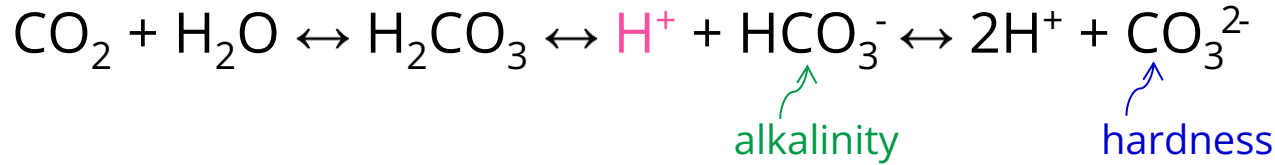
General concepts

Carbon dioxide chemistry

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The CO₂ reacts with water to **drop the pH**



For swimming pools: pH between 7.2 - 7.6

Other products to decrease the pH: HCl, H₂SO₄

Water hardness

- Measures the water's ability to produce scale through the formation of insoluble carbonate and hydroxide precipitates
- Unit of measurement for water hardness:
1 French degree (°fH) = 10 mg CaCO₃/L H₂O (10 ppm CaCO₃)
- The ideal hardness ranges between 80 and 250 mg/L (ppm) ⁽¹⁾

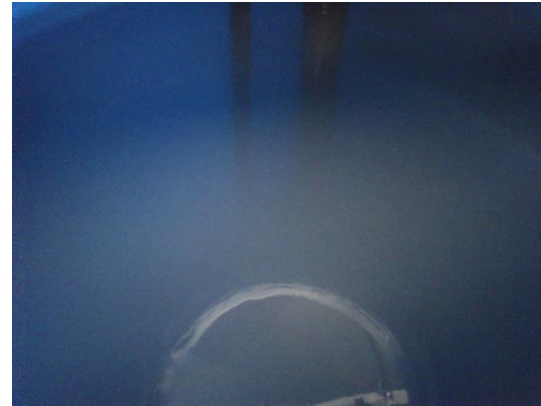
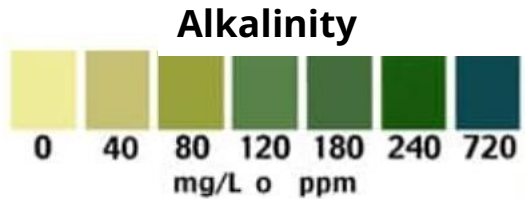
Water hardness chart

Classification	mg/l or ppm
Soft	0 - 17.0
Slightly hard	17.1 - 60
Moderately hard	60.1 - 120
Hard	120.1 - 180
Very hard	> 180



Water alkalinity

- Alkalinity is a measure of water's ability to neutralize acids and is mainly caused by dissolved bicarbonate and carbonate salts
- Therefore, the higher the alkalinity, the greater the consumption of acid (pH reducer) or CO₂ needed to lower the water's pH
- The unit of measurement for alkalinity is: mg of CaCO₃ /L H₂O
- The recommended alkalinity ranges between 80 and 200 ppm⁽¹⁾

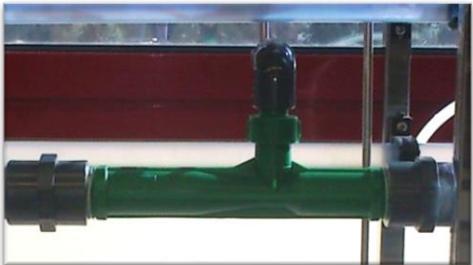


Optimisation of CO₂ injection in swimming pools for pH neutralisation

Air Products development

The objective of our application is to make the recreational waters facilities healthier and environmentally friendly by using CO₂ instead of hydrochloric acid, as pH reducer.

The optimisation of the *Halia*[®] pH neutralisation system allow us to find the best CO₂ dissolution efficiency to be able to offer to the customers a safer solution for pH reduction with an optimum consumption of CO₂.



Halia[®] pH neutralisation system pilot plant at Bellaterra (Barcelona - Spain)

Conclusions

In accordance with the results obtained the installations should comply the following requisites:

1. Disinfectant (NaClO) should be injected before the CO₂
2. pH sensor should be located between NaClO injection and CO₂ injection point
3. Install two diffusers separated at least 1 m
4. Water velocity should be between 1 and 2.5 m/s:
 - if it is lower: set up an *Halia*[®] neutralisation system with a smaller diameter than main pipe (increase water velocity)
 - if it is higher: set up an *Halia*[®] neutralisation system with same diameter than main pipe (increase CO₂ residence time into water)

Examples of improvements with new optimised parameters

Customer	% reduction in CO ₂ consumption
Hotel A	30.3
Hotel B	22.7
Hotel C	21.7
Hotel D	23.5



Installation examples

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Municipal:

- Semi-Olympic pool
- Training pool
- Spa



CO₂ control panel



CO₂ diffuser

pH sensor

Installation examples

Municipal:

- Semi-Olympic pool
- Training pool
- Spa



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CO₂ diffusion system:

- Cryoease
- 2 injection points with diffuser
- > 40m pipe length



Recirculation pump for disinfection and pH neutralisation



Benefits of using CO₂ instead of mineral acids

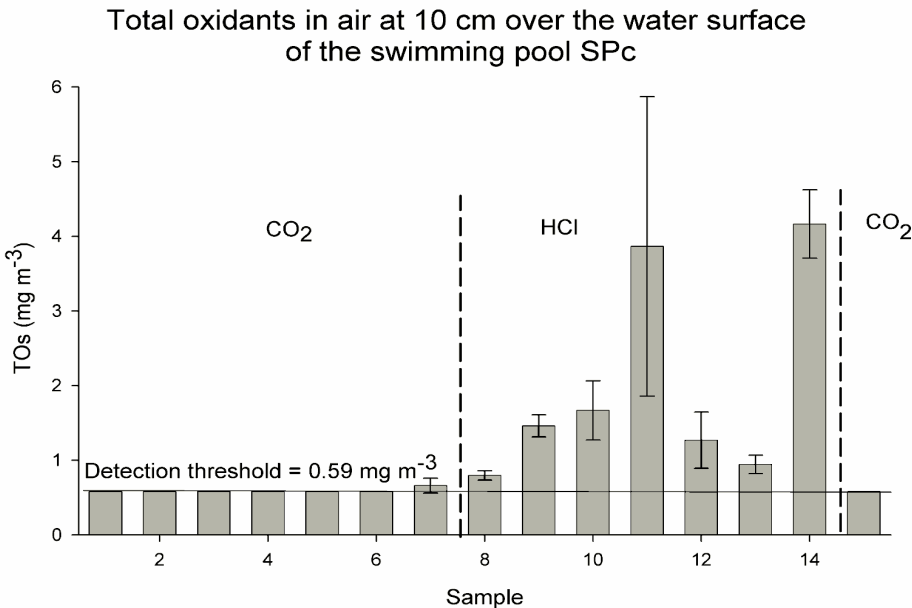
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- **Swimming pools** are associated to wellness and health. However, they require a degree of disinfection to avoid microbiological pollution.
- **Chlorine-based disinfectants**, such as NaClO, are the most frequently used in swimming pools. When chlorine reacts with natural organic matter, disinfection by-products (DPB) such as chloramines or trihalomethanes (THM) are formed, resulting in a health hazard.
- A **pH reducer** is also needed, because of the continuous addition of disinfectant, to keep the water pH at 7.4 value. Commonly, hydrochloric acid and sulphuric acid are used.



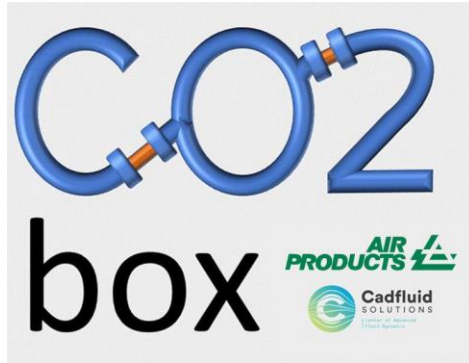
Benefits of using CO₂ instead of mineral acids

- **Less formation of oxidants and THM** in the air above the pool, with a reduction in health concerns (asthma, skin irritations, etc.) in the swimmers.
- **Safer handling** of the facility avoiding the risk of accidental mixing of HCl and NaClO and thus, chlorine gas formation.
- More **gradual pH reduction** than with mineral acids, making accurate control easier.



CO₂ Box: A Tool for estimating CO₂ consumption

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CO2box

Menu

AIR PRODUCTS

Excel file Run
Image file Exit

Flow conditions

Liquid

Flowrate (m³/h) 90
Pressure gauge (bar) 2.5
Temperature (°C) 27
Velocity (m/s) 2.32
Pressure drop (bar) 0.065

Gas (CO₂)

Flowrate (kg/h) 4
Bubble diameter (mm) 2

Pipe characteristics

Diameter (mm) 120
Maximum length (m) 10
Roughness (mm) 0.0043

Liquid chemical conditions

Inlet pH 7.8
Alkalinity (ppm CaCO₃) 100
 Value
 High
 Medium
 Low

Select the plot
pH Evolution: Stratified vs...

pH Evolution: Stratified vs. Bubble flow

The graph plots pH on the y-axis (ranging from 6.6 to 7.8) against Pipe Axial Length [m] on the x-axis (ranging from 0 to 10). Two curves are shown: a red line for 'Stratified Flow' and a blue line for 'Bubbles flow'. Both curves start at a pH of 7.8 at 0 meters and drop sharply, reaching a plateau of approximately 6.65 by 4 meters. The 'Bubbles flow' curve drops slightly faster than the 'Stratified Flow' curve.

Cadfluid SOLUTIONS
Center of Advanced Fluid Experiments

Questionnaire: pool details for CO₂ analysis

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Customer name: XXXX Contact: XXXX Tel: 1123456789 File No: 33/20222
Address: erewxvqer Email: xxxxxxxx@airproducts.com Date: 27/04/2025
AP contact: Air Products contact name Internal pipe diameter (mm): 333

Disinfectant used? (i.e.: hypochlorite, electrolysis...): white here
Note: if there are several effluents to be treated, the data for each of them should be indicated.

1. Plant Characteristics

Nº of effluents to treat: 4
Water volume of the pool (m³): 222
Average water flow (m³/h): 22
Maximum water flow (m³/h): 33
Pump power (W): 33
Line pressure (bar): 333
Water recirculation hours per day (H/day): 22
Pipe length: reducer injection to pool (m): 333

2. Current pH reducer data

pH reducer used (HCl, H₂SO₄, CO₂,...): xcvcvxvc Purity (%): 55
Supplier: Write supplier name pH reducer price (€/l): 55
pH reducer bin capacity (l): 1111 pH reducer consumption (l/month): 55
Is the pH reducer dosified automatically Yes No

3. Water data

Initial pH: 33 Desired final pH: 333
Total Alkalinity (ppmCaCO₃): 22 Hardness (ppmCaCO₃): 333
Water temperature (°C)*: 44
**Important parameter if spa/hot tub*

4. Observations

Start writing here
write here



Additional resources

CO₂ pH Control for Swimming Pools

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[CO₂ pH Control for Swimming Pools | Air Products](#)

[Should you be using chlorine in swimming pools? | Air Products](#)

[Pool water treatment: Switching from chlorine to carbon dioxide | Air Products](#)

https://youtu.be/YSimLH_0FEA

[How CO₂ Impacts Pool Chemistry | Air Products](#)

[Common Misconceptions About CO₂ in Pool pH Management | Air Products](#)

[Halia® QM pH Neutralisation Systems](#)

[Co₂ Gas Suppliers. | Co₂ Gas Company | Air Products](#)



Thank you

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